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MICROPROCESSOR CONTROLLED DOWN-THE-HOLE DRILL

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MICROPROCESSOR CONTROLLED DOWN-THE-HOLE DRILL

by

J. Pathak* and S.F. Baginski**

ABSTRACT

One of the most important breakthroughs in underground hard rock mining came in 1973/74 with the development by Inco and CIL of Vertical Crater Retreat mining (VCR) a bulk mining method, using special explosive charges. It is a more productive method with productivity exceeding 100 t ms and safe because miners do not have to work directly in the stopes under newly blasted rock. It provides a very high ore inventory.

Down-the-hole drills (DTH) are widely used. Although they are the preferred drill, further development of the drill is required with respect to accuracy of setting, on-line azimuth and deviation reporting and performance optimization. Additions or improvements in these areas would lead to enhanced stope productivity, the use of larger stope height and improved fragmentation.

In response to the challenge, Vadeko International Inc. of Mississauga, Ontario proposed the development of a prototype with the following features: a drill system which would maintain the percussive drilling process at its optimum, reduce the rig setup time, increase setup accuracy and provide on-line information on bit position.

After technical review, funding for the proposed research project by Vadeko International Inc. was provided by the Department of EMR and the Department of Supply and Services. The proposed completion date for the project is May 1986.

The system now under development by Vadeko is called the Rig Control System (RCS) and is comprised of four major subsystems:

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FOREUSE À MARTEAU PLONGEUR COMMANDÉE PAR MICROPROCESSEUR

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RESUME

Un des plus importants progrès dans l'exploitation minière souterraine de la roche dure a été la mise au point en 1973-1974 par l'Inco et la CIL de l'exploitation rabattante par entonnoirs verticaux, (Vertical Crater Retreat mining, VCR), une méthode d'abattage en masse faisant intervenir des charges explosives spéciales. C'est une méthode plus productive, permettant de dépasser les 100 t ms, et sécuritaire puisque les mineurs n'ont pas à travailler directement dans les chantiers d'abattage sous la roche nouvellement abattue. Elle assure des stocks très importants de minerai.

Les foreuses à marteau plongeur sont abondamment utilisées. Bien qu'elles soient les foreuses préférées, elles pourraient faire l'objet d'améliorations quant à la précision du réglage, au signalement en direct de l'azimut et de la déviation ainsi que d'une optimisation du rendement. Ces améliorations permettraient d'accroître la productivité des chantiers d'abattage, d'exploiter des chantiers sur une plus grande hauteur et d'améliorer la fragmentation.

Afin de relever ce défi, la Vadeko International Inc. de Mississauga (Ont.) a proposé la mise au point d'un prototype présentant les caractéristiques suivantes : un système de forage qui optimiserait le processus du forage par percussion, qui réduirait le temps d'installation de l'appareil de forage, qui accroîtrait la précision de cette installation et qui fournirait en direct des renseignements sur la position du fleuret.

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Après examen technique, Energie, Mines et Ressources et Approvisionnements et Services ont subventionné le projet de recherche présenté par la Vadeko International Inc. On a proposé mai 1986 comme date de parachèvement du projet.

Le système actuellement mis au point par la Vadeko est appelé Système de commande de l'appareil de forage et se compose de quatre sous-systèmes principaux :

Mots-clés : Automatisation du forage, exploitation minière de la roche dure, abattage en masse, équipement minier commandé par microprocesseur.

- Rig Setup (RSS)
- Instrumented Rod (IRS)
- Drill Performance (DPS)
- Performance Control (PCS)

1. The RSS subsystem facilitates quick and accurate positioning of the drill rig with respect to surveyors markings. It has a high-powered light source (see conceptual drawing in Fig. 1) gimbal-mounted on the rig. The light is beamed on the markings. Pertinent data is entered into the PCS which calculates the co-ordinates of the rig. Similarly, it calculates the co-ordinates of the drill hole collar and indicates the adjustment needed to arrive at the correct drill position. When the rig is at the specified position, the operator can then adjust the drill mast to provide the correct azimuth and dip. RCS displays azimuth and dip angles within ±0.5% error on a real time basis. The setup parameters are recorded and stored by the PCS. Subsystem data can be retrieved as and when required.
2. The instrumented rod (IRS) is placed right behind the stabilizer and lowered as per standard procedure. It is a conventional rod except that a recess is provided for housing the instrumentation sensor and power supply. A special, extremely rugged set of sensors is used to measure rod orientation and transmit the signals to the rig's PCS. The PCS compares the actual deviation of the rod to the intended deviation and if it exceeds the preset tolerance level, it stops the drilling.
3. The function of the Drill Performance subsystem (DPS) is to monitor and control parameters, such as bit thrust, rod rpm (indexing speed), air quantity etc., which are critical to achieving optimum drill performance. Two pressure sensors are used to read the net force exerted by the cylinder on the steel rod. With this information, the PCS subsystem calculates the thrust on the bit. A pressure control valve is connected in parallel to the standard valve to allow the operator to exercise manual control if so desired. A brushless resolver mounted directly on the rotating head monitors the rod rpm (indexing speed) which is controlled by a speed flow valve in parallel with a manual control valve. Compressed air is similarly monitored by a pressure sensor and controlled by a solenoid operated air valve.

4. A microcomputer housed in the PCS unit receives information from IRS, RSS and DPS units and external databases such as the main computer or surveyors databank of the mine. It is capable of processing setup data, drilling parameters etc., and on-line control performance of the drill. It displays required informations on CRT (option), prints out required reports and sends information to surface based computer for further processing and report preparation.

   The PCS is equipped with extensive Input/Out hardware and coupled to the programmable controller assembly.

   Extensive software package will handle communications, operator interface, all necessary logic and real-time controls.

   The design criteria adopted are the following:

   - Retrofit Accessory
   - Machine Independent
   - Modular
   - Interchangeability
   - Simplicity (for operators)
   - Digital information retrieval for engineers.

When the system is proven, it is expected to increase setup accuracy and decrease setup time, prevent holes being drilled exceeding preset deviation tolerance levels, maintain highest possible penetration rates, and ease operator effort. It will result in higher productivity, less wastage of blast holes and lower drilling costs. The next stage will be to further increase the PCS ability to control borehole deviation further enhancing productivity and the quality of fragmentation.

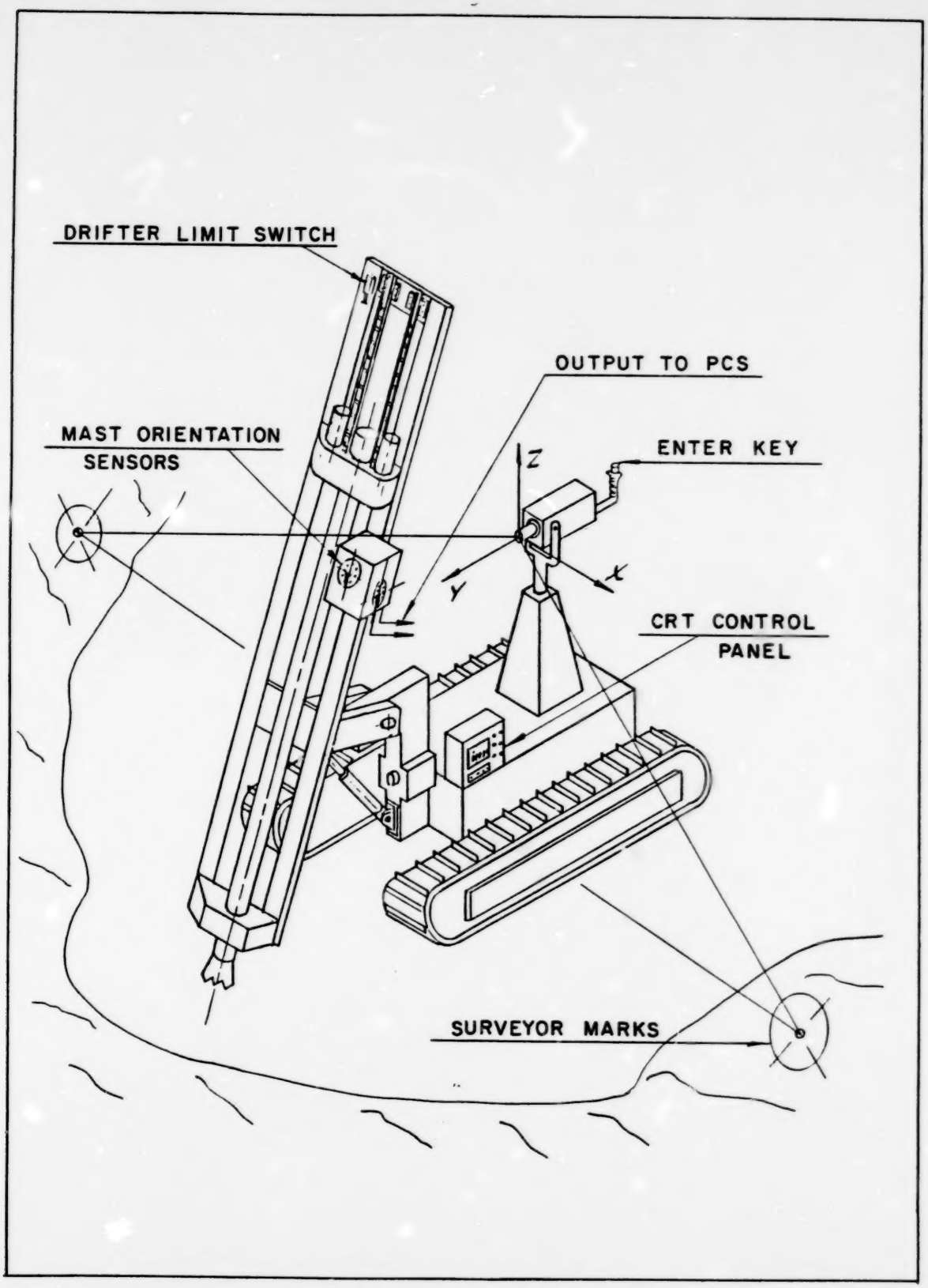

Fig. 1 - Down-The-Hole Drill Rig Control System.